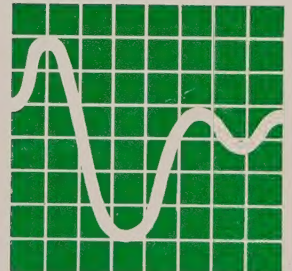


INSTRUCTION MANUAL

MODEL QSA

WIDE RANGE

SORENSEN POWER SUPPLIES





INSTRUCTION MANUAL
MODEL QSA
WIDE RANGE

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GENERAL INFORMATION

WARRANTY

Raytheon warrants all parts of equipment of its manufacture, except special purpose tubes and semiconductor devices, which carry their own manufacturer's warranty, to be free from defects caused by faulty material or poor workmanship. Raytheon warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgment form to be free from defects caused by faulty material or poor workmanship. Raytheon's obligation is limited under the warranty to repair or replacement of products in kind, or at its sole option to issuance of a credit of original purchase price. Returns must be accompanied by a Raytheon Return Authorization form and conform to standard conditions for adjustment. The aforesaid warranty shall expire twelve (12) months following the last day of the month of shipment from Raytheon's plant. The foregoing states the entire warranty extended by Raytheon. No other warranty, express or implied, is made and, specifically, Raytheon makes no warranty of merchantability or fitness for any purpose. In no case shall Raytheon be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

RAYTHEON COMPANY, Sorensen Operation

SERVICE INFORMATION

Questions concerned with the operation, repair, or servicing of this instrument should be directed to the nearest Sorensen representative (a list is included with this manual) or to the Service Department., Sorensen/A Unit of Raytheon Company, Richards Avenue, South Norwalk, Connecticut. *Include the model number and serial number, in any correspondence concerning this instrument.*

SHIPPING DAMAGE

It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be tested and inspected as soon as it is received. If the instrument shows signs of damage, follow the instructions on the DAMAGE and/or Loss in Shipment form enclosed with the unit and notify the carrier immediately. The carrier's claim agent will then prepare a report of damage and, after you have forwarded this to the Sorensen Service Department, you will be advised as to the action necessary to have the instrument repaired or replaced.

RETURNS TO THE FACTORY

Should it be necessary to return an instrument to the factory for repair, please contact the Sorensen Service Department for authorization to make shipment.

RAYTHEON COMPANY WILL ASSUME NO RESPONSIBILITY FOR MATERIAL RETURNED WITHOUT PRIOR AUTHORIZATION.

II. SPECIFICATIONS

MODEL		QSA10-1.4	QSA10-2.2	QSA10-3.7
OUTPUT VOLTAGE (Vdc)		0-10	0-10	0-10
OUTPUT CURRENT (Adc)		0-1.4	0-2.2	0-3.7
VOLTAGE REGULATION (line and load combined)		← ± 0.005% or ± 0.5 mV →		
OUTPUT RESOLUTION (Typ)		← 28 millivolts →		
RIPPLE VOLTAGE	RMS	← 300 microvolts →		
	Peak to Peak	← 3 millivolts →		
RESPONSE TIME		← 20 microseconds →		
AMBIENT TEMPERATURE for % Load Current		{ 40°C/ 110% 50°C/100% 60°C/ 85% 71°C/66% }		
TEMPERATURE COEFFICIENT		← 0.01%/°C or 0.5 mV/°C * →		
STABILITY		← 0.025%/8 hrs. ** →		
OUTPUT IMPEDANCE (μohms + L)		300 + .2μh	200 + .2μh	100 + .2μh
OVERLOAD PROTECTION		← Current Limit →		
PROGRAMMING		← 100 ohms/volt →		
SERIES/PARALLEL		← Up to 20 units in series - 4 in parallel *** →		
REMOTE SENSING		← 1.5 volts drop maximum per lead →		
RFI		← MIL-I-16910, MIL-I-26600 and MIL-I-6181D →		
INPUT VOLTAGE (Vac)		← 105-125; 200-240; 210-250 Single Phase →		
INPUT FREQUENCY (Hz)		← 50 - 480 →		
OVERALL DIMENSIONS (Inches)	Width	3-7/8	5-1/8	5-1/8
	Height	3-5/16	3-5/16	3-5/16
	Depth	7	7	10
WEIGHT (Lbs.)	Net	5	8	10
	Shipping	8	11	13

* Whichever is greater

** To insure stability spec, rotate output control a few times for good wiper contact.

*** Derate each unit to 90% of its nominal maximum current rating.

SPECIFICATION NOTES

NOTE 1: FREQUENCY RANGE

This unit will operate over the input frequency range listed. However, all specifications are guaranteed only at 60 cps. The ripple voltage will increase as the frequency is varied from 60 cps.

NOTE 2: RECOVERY TIME

When an abrupt change occurs in the input voltage or output load, an instantaneous change in output voltage occurs. This instantaneous change is quickly suppressed by the regulating action of this instrument. Recovery time is the time for recovery to within a voltage band centered about the mean value of the steady state level existing before and after the change. For full load changes the band is ± 10 millivolts.

III. INSTALLATION AND OPERATION

See outline drawing on the next page for mounting information. Do not restrict air circulation to the exposed surfaces of the unit.

Terminals and Controls

1. Input Power Connections

Input power connections are made to terminals 6 and 7 of the terminal board at the rear of the case. Terminal 5 of the terminal board should be solidly grounded to the power line wiring system, preferably soldered.

Note: The input circuit is set up at the factory for 115 volt single phase operation. For 220 volt or 230 volt operation the primary wiring to the transformer T1 must be re-arranged as shown in Figure 1.

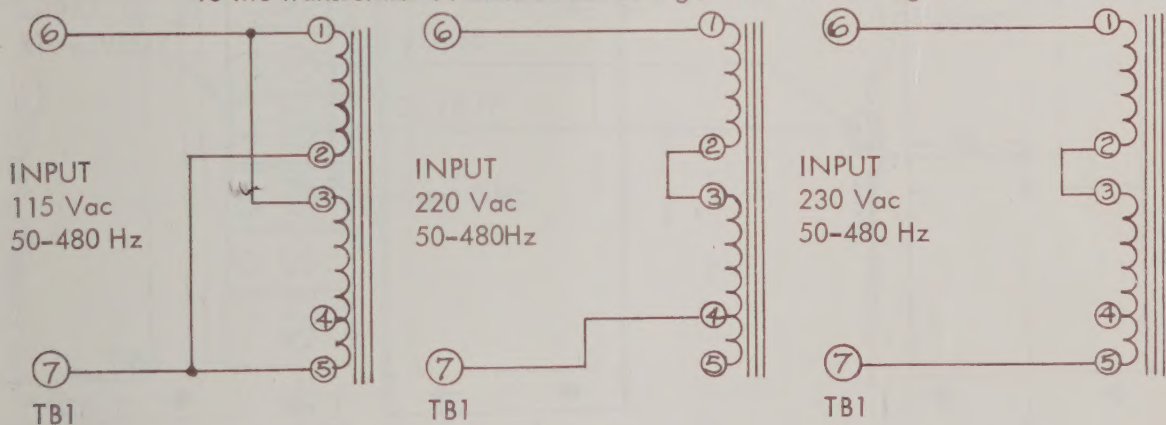


Figure 1

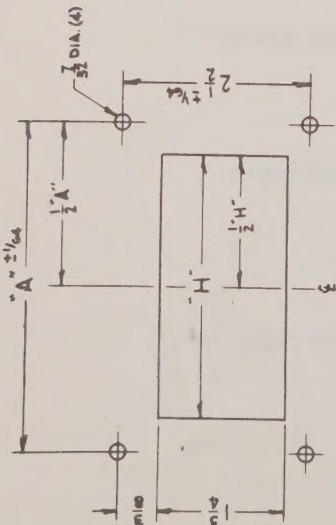
Caution: The input must be fused at twice the nameplate current rating.

2. Output Power Connections

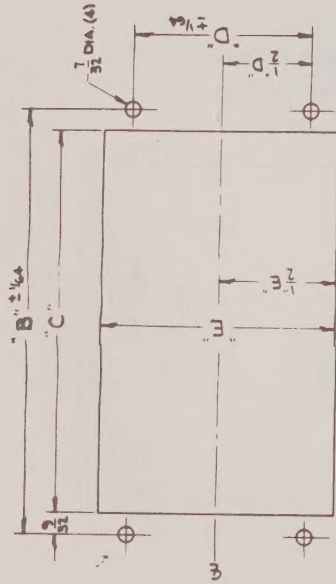
The output power is available at terminals 1 and 4 of the terminal board. External sensing is provided through terminals 2 and 3.

3. Output Adjustment

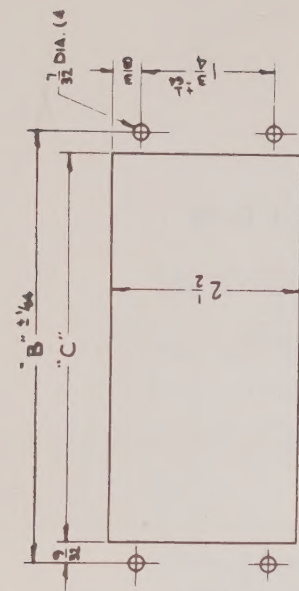
A potentiometer (R18) with a slotted shaft is located at the lower right hand corner of the nameplate. It is used to vary the output voltage.



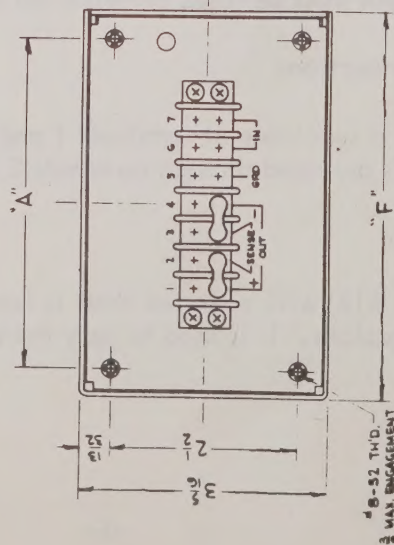
RECOMMENDED MTG. K.O. END MTG.



RECOMMENDED MTG. K.O. BOTTOM MTG.

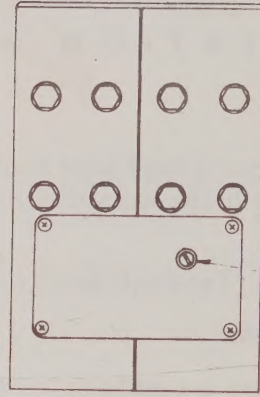


RECOMMENDED MTG. K.O. SIDE MTG.



RECOMMENDED MTG. K.O. END MTG.

RECOMMENDED MTG. K.O. SIDE MTG.



RECOMMENDED MTG. K.O. SIDE MTG.

MODEL SERIES	DIM. A	DIM. B	DIM. C	DIM. D	DIM. E	DIM. F	DIM. G	DIM. H
QSA (15W)	3 1/8	5 1/16	5 1/8	2 3/8	2 3/8	3 7/8	6 9/16	3 5/8
QSA (20W)	4 3/8	5 1/16	5 1/8	3 5/8	3 5/8	4 7/8	6 9/16	4 5/8
QSA (41W)	4 3/8	8 1/16	8 1/8	3 5/8	3 5/8	5 1/8	9 3/16	4 5/8

OUTLINE DRAWING QSA SERIES

4. Sensing

For local sensing, the output terminals (1 and 4) are connected to the sensing terminals (2 and 3) by links. The power supply is shipped set up for local sensing. For remote sensing, the sensing links must be removed from the output and sensing terminals and external leads connected from the unit to the load as shown in Figure 2. Observe polarity.

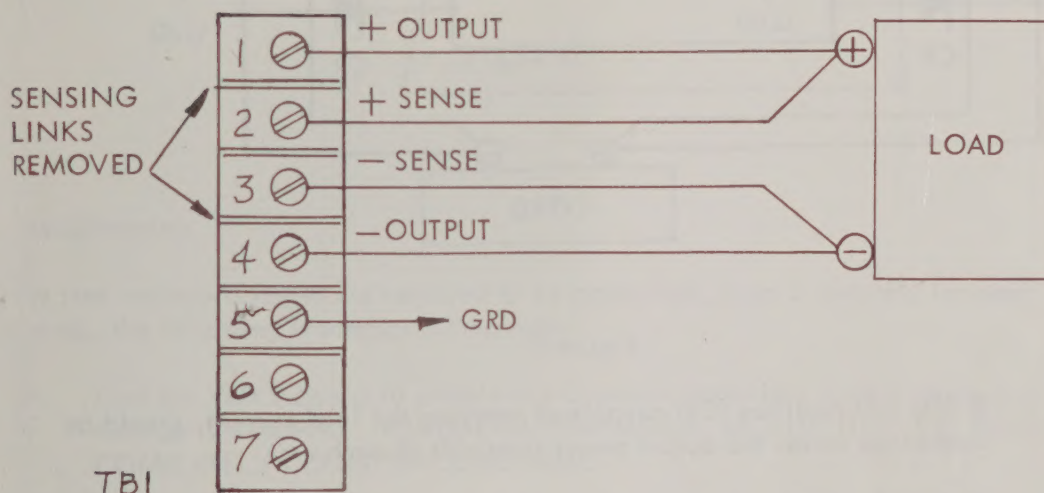


Figure 2

For remote sensing it is recommended that shielded cable, such as RG/U coaxial of correct wire size, be used for sensing and power leads. Maximum allowable voltage drop in each lead is 1.5 volts.

It is further recommended that the output capacitor ~~C8~~^{C7} be removed from the unit and installed at the remote point. This tends to maintain the normal output impedance and fast transient response characteristics of the instrument, while remote sensing.

Sensing connections must be kept tightly fastened at all times of operation.

5. Series Operation

When operating QSA power supplies in series, the output terminal boards must be connected as shown in Figure 3 not more than 20 units may be operated in series.

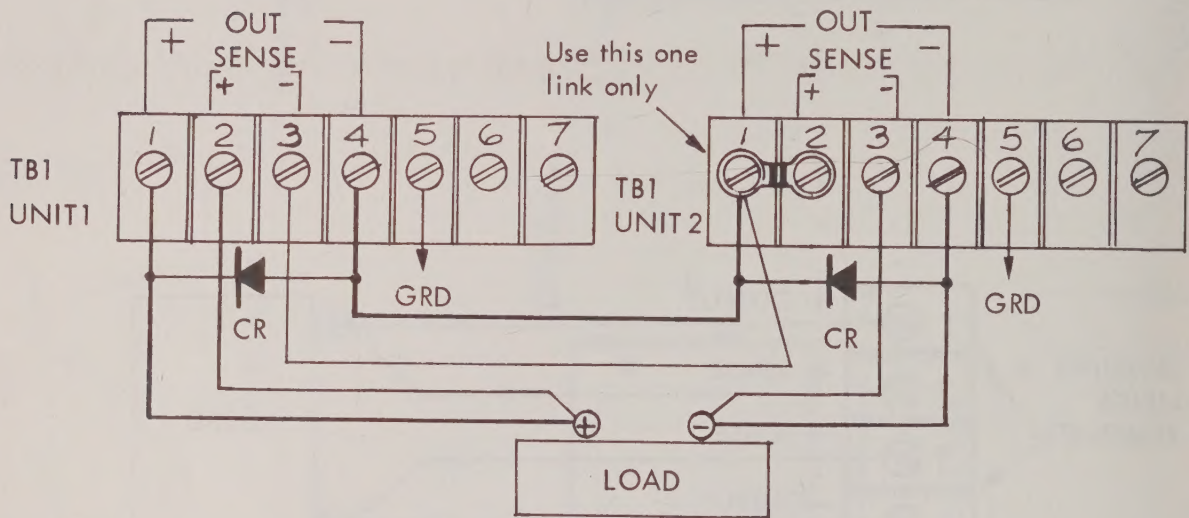


Figure 3

A 100 volt rectifier (CR) capable of carrying the load current, should be connected across the output power terminals of each unit.

Note: Sensing leads must be on top of load wires as they are fastened to the terminals of the load.

6. Parallel Operation

A maximum of four (4) units may be operated in parallel. When operating QSA power supplies in parallel, only one of the supplies may act as the sensing source and amplifier; therefore, the amplifier Q10 in a "master" unit is used to drive the Darlington connection in all the units in parallel. (See Figure 4).

First remove the input power from all units. Then remove the jumper terminals E1, E2 (located at the upper center of the printed circuit board) of all units except the " master" unit. A connection is then made from terminal E1 of the " master" to terminal E1 of all other units. Units are now ready for parallel operation.

Note: Derate each unit to 90% of rated output current.

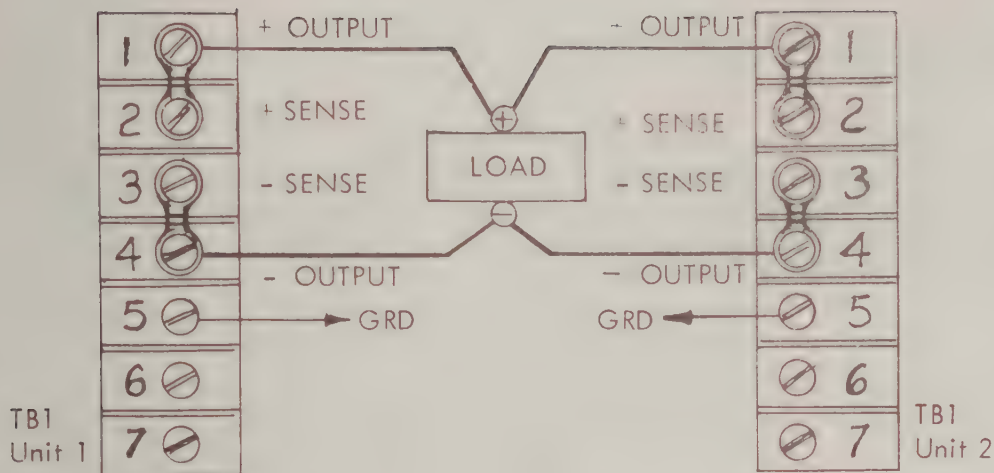


Figure 4

7. Programming

If step voltage changes are required to be controlled, from a remotely located area, the following procedure is necessary.

- Turn the Volt Adjust R18 completely counter-clockwise, so that the output voltage is minimum. WHILE PROGRAMMING, BE SURE THAT R18 REMAINS COMPLETELY COUNTER-CLOCKWISE.
- Remove input power from the unit. Remove side panel covering Printed Circuit Board.
- Remove jumper from term E5 and E6 on Printed Circuit Board. (Do not use excessive heat).
- Connect the desired remote resistance between terminal E5 and E6.

The value of the programming resistance may be determined by using a ratio of $100 \mu/\text{volt} \pm 0.5\%$.

For remote programming it is recommended that shielded cable, such as RG/U coaxial of correct wire size, be used.

8. CURRENT LIMIT

Overload protection is provided by a current limit circuit. This circuit is factory adjusted for use at ambient temperatures up to 40°C. If temperatures above 40°C exist, we recommend readjustment of current limit to 135% of either the 50, 60 or 71°C nameplate current rating whichever applies. See chapter V Maintenance and Repair for current limit circuit adjustment.

NOTE: Current Limit can not be set below 125% of the nameplate current rating at 71°C.

IV. PRINCIPLE OF OPERATION

The Model QSA is a regulated DC power supply. The operation of this instrument can best be understood by referring to the block diagram, Figure 5, shown below and to the schematic diagram. This manual covers the wide range QSA models only.

1. INPUT POWER SUPPLY AND RECTIFIER

The main power supply employs a full wave rectifier with capacitor input filtering (CR1, CR4 and C3). The output of this circuit is fed to the series passing stage and the output terminals. Refer to Figure 6.

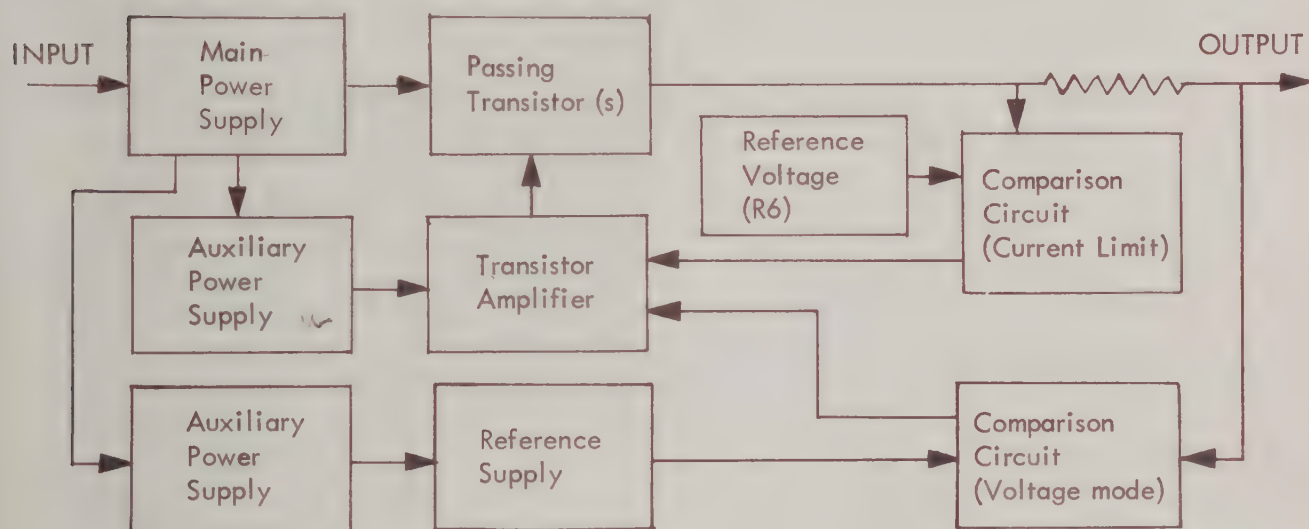


Figure 5

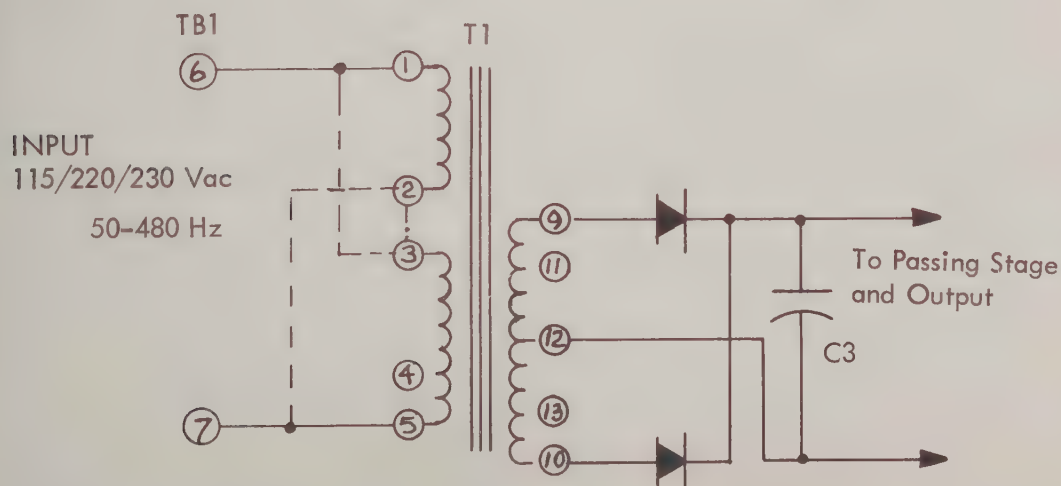


Figure 6

2. THE PASSING TRANSISTOR

The passing transistor (s) Q2 acts as a variable impedance in series with the main power supply voltage. See Figure 7. The output voltage, therefore, is equal to the main power supply voltage less the drop across the passing transistor. If the output voltage tends to rise, due to a line or load change, the passing transistor impedance increases. The result is additional transistor voltage drop which causes the output voltage to remain at the preset value. If the output voltage tends to fall, the impedance of the passing transistor decreases and additional voltage will be supplied to the output terminals. This causes the output voltage to remain at the preset value. R7 is an emitter balancing resistor which insures the equal distribution of the load current through each transistor, when two passing transistors are used in parallel.

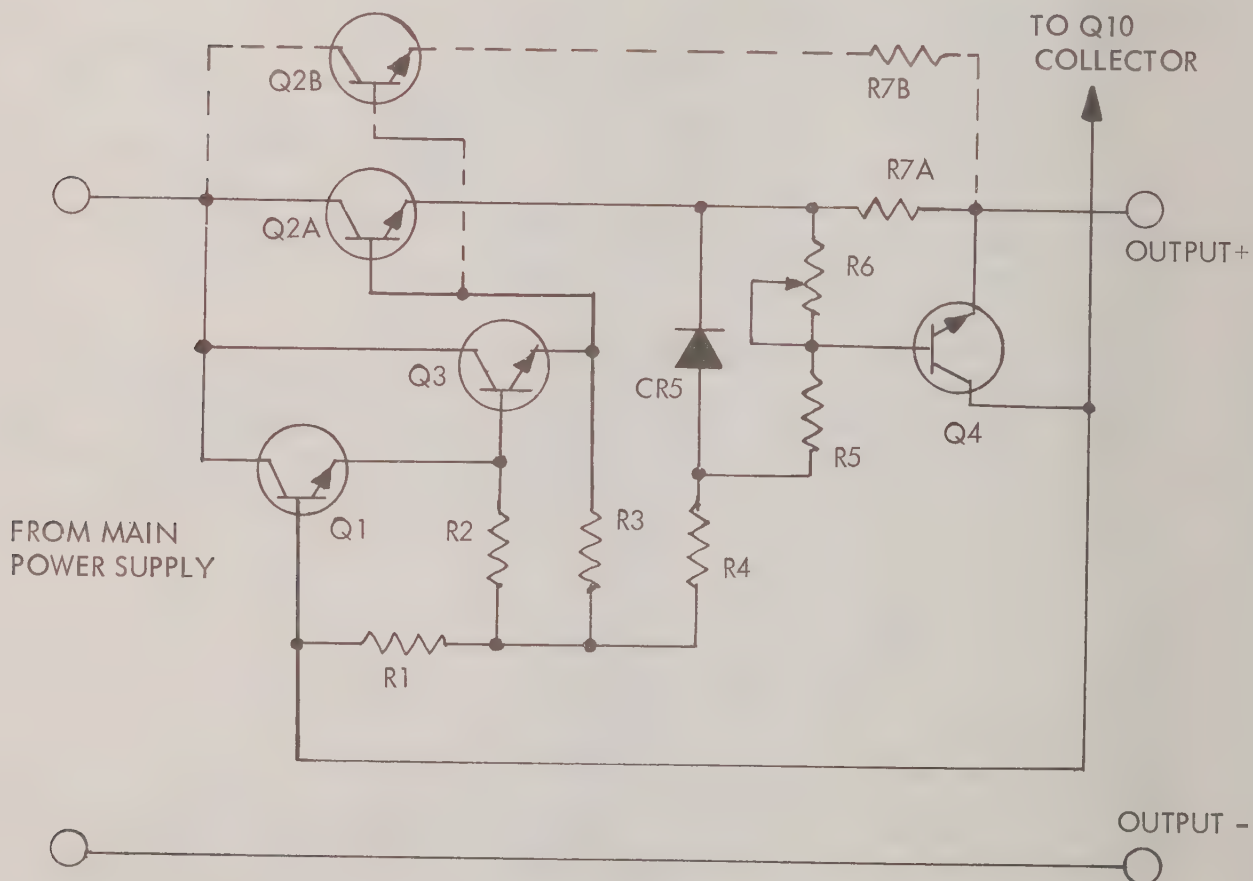


FIGURE 7

3. THE SENSING CIRCUIT

The Sensing Circuit consists of resistors R18 and R25. This Sensing Circuit is across the output voltage at the load point. Therefore, a sample of the output voltage appears across the resistor R25.

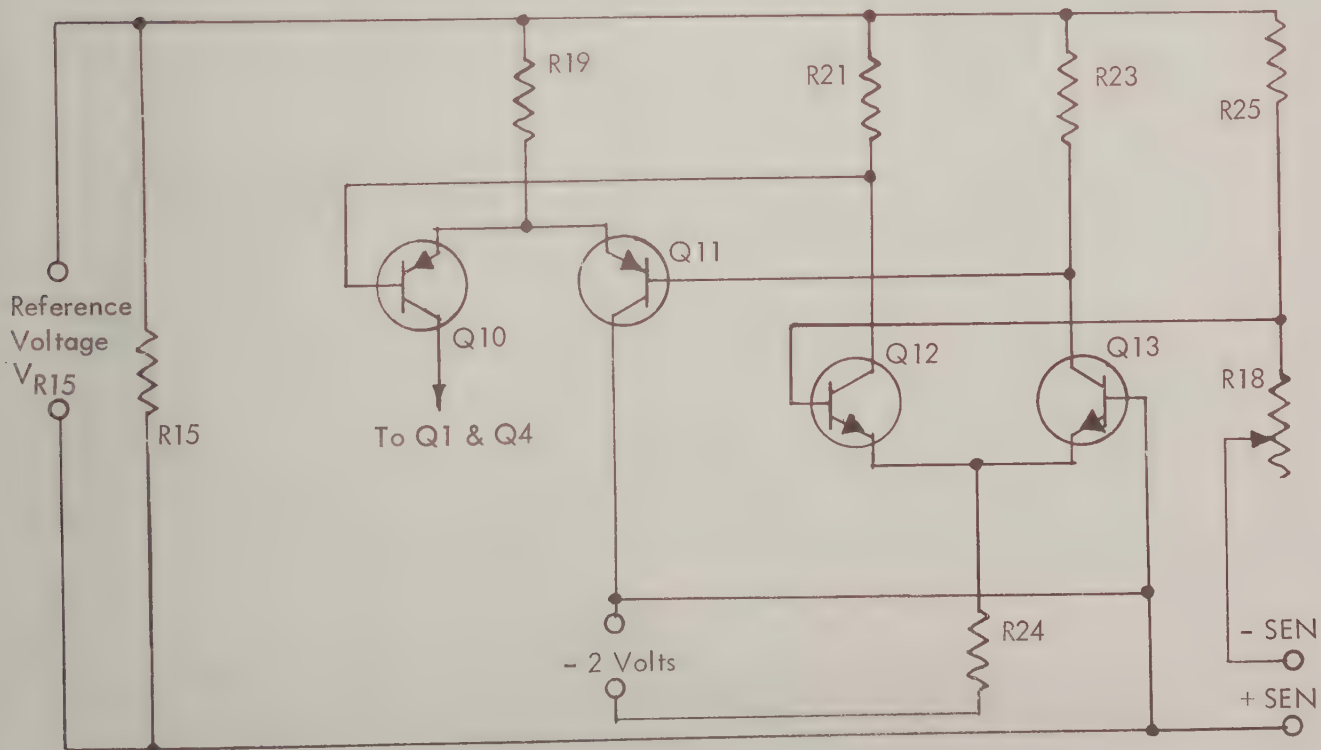
4. THE COMPARISON CIRCUIT AND THE AMPLIFIER

Resistors R15 and R25 are two arms of a bridge in which a portion of the output voltage (V_{R25}) is compared to a reference voltage (V_{R15}).

The difference voltage or error signal is applied to the differential amplifier Q12, Q13. The output of this amplifier is fed to a second differential amplifier Q10, Q11. See Figure 8.

The error signal, amplified through the two differential amplifiers, is used to drive the base of Q1. This controls the current in the Darlington circuit and therefore the impedance of the passing transistor (s).

For example, if the output tends to rise, the point at the junction of R25 and R18 will be more negative. The base emitter potential of Q12 will decrease causing the collector current of Q12 to decrease. The voltage drop across R21 will therefore decrease causing Q10 base to have a higher potential and Q10 will draw less current. The current to the Darlington connection will thus be reduced and since the base of Q2 will have less drive its impedance will increase. More of the main power supply voltage therefore will drop across the passing stage lowering the output voltage to the preset value. If the output tends to fall, the opposite effects will produce a decrease in the impedance of the passing stage. This will keep the output at the preset value.



5. THE REFERENCE CIRCUIT

The Reference Circuit consists of transistor Q5, Q6, Q7, Q8, Q9 and associated circuitry. See Figure 9. It is, in effect, a regulated power supply which supplies the reference voltage V_{R15} . Across the output voltage V_{R15} is the constant load of the sensing string and the feedback amplifier Q10, Q11, Q12, and Q13.

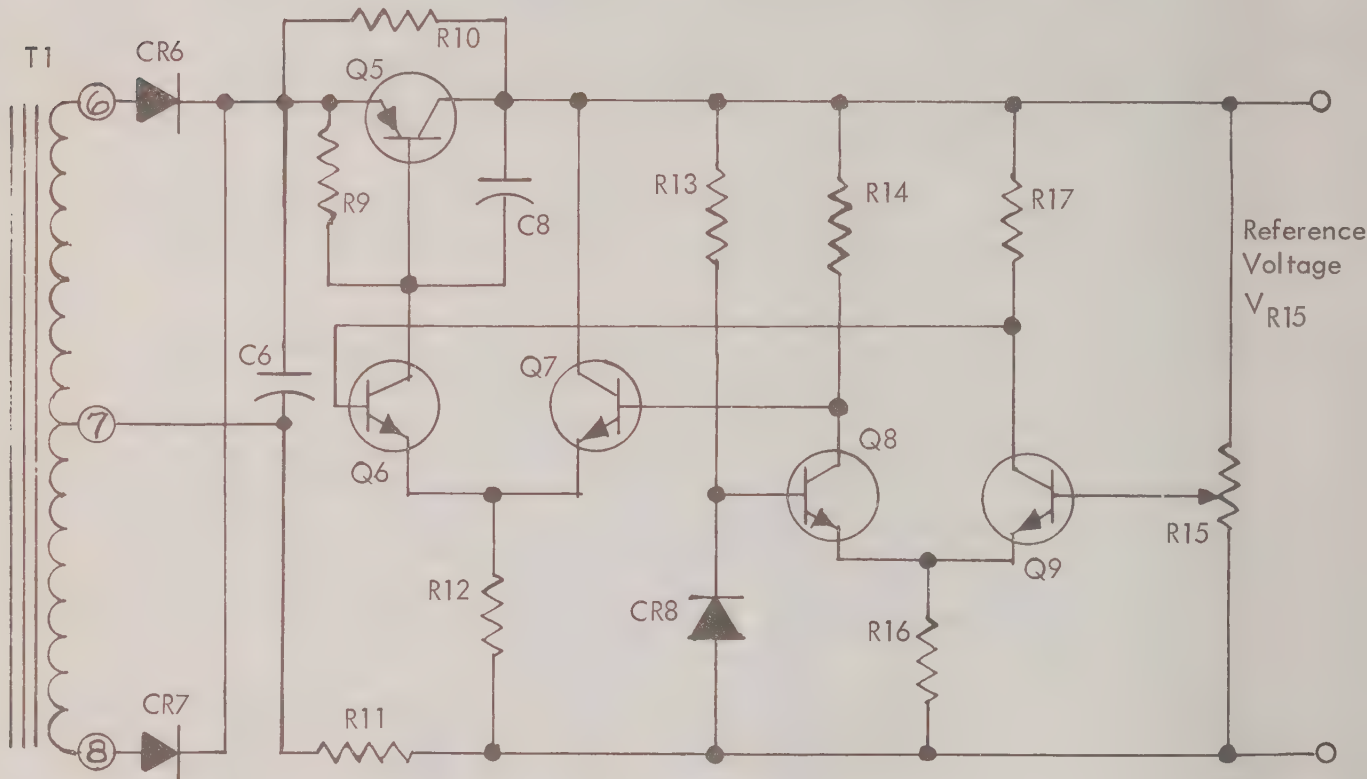


Figure 9

Zener diode CR8, resistor R13 and potentiometer R15 form a comparison circuit. In this circuit the reference voltage of the zener CR8 is compared to the portion of the voltage V_{R15} , which appears between the arm of R15 and the junction of R15, CR8.

Since the load on the reference circuit is constant, the reference is essentially a line voltage regulator. For example, if the input line voltage rises above a nominal value, the voltage V_{R15} tends to rise. The potential at the arm of R15 will also rise, increasing the Q9 base emitter voltage. Therefore, the collector current of Q9 will increase. The voltage drop across R17 also will increase and therefore Q6 base will be at a lower potential. The current through Q6 will be reduced and less current will be available for the base of the passing transistor Q5. The impedance of Q5 will increase and more of the reference supply voltage will drop across this stage keeping the V_{R15} at the preset value.

If the input line voltage falls below a nominal value, the voltage V_{R15} tends to go lower. However, the opposite effects of the above example will produce a decrease in the impedance of Q5. This will keep the voltage V_{R15} at the preset value.

6. CURRENT LIMIT CIRCUIT

When a preset condition of current and voltage is exceeded, Q4 conducts drawing current from the Q10 output circuit. This reduces the available current to the Darlington so that the impedance of the passing stage increases. The voltage drop across the passing stage increases and the voltage at the output is therefore reduced. Reduced output voltage causes a decrease in the voltage drop across R6. Since the voltage across R6 is the reference voltage for the current limit circuit, reduction of this voltage causes a degeneration in this circuit. As a result, the current through R7 will decrease. Thus, the output voltage and the output current will both be reduced to a safe value. See Figures 7 and 10.

V. MAINTENANCE AND REPAIR

During normal life this instrument requires no maintenance other than the care afforded similar equipment. It is suggested that excessive dust and any other foreign matter be removed periodically, exercising care to prevent damage to the instrument by cleaning tools or excessively strong air blasts.

CAUTION: KEEP ALL TERMINAL BOARD LINKS TIGHT AT ALL TIMES

1. Trouble Shooting Chart

Only qualified personnel understanding transistorized regulator circuitry should attempt the repair of this unit, if damage should occur. Major servicing should be done only by the factory or one of its representatives.

Symptom	Probable Cause	Procedure for Repair
1. High Output	1a. Shorted passing stage (Q2) 1b. Open: Q7, Q9, CR8, R15 wiper, Q11, Q13 Shorted: Q1, Q3, Q4, Q5, Q6, Q8, Q10 1c. Sensing link open	1a. Check for defective transistor 1b. Check for defective transistor 1c. Check links
2. Low Output	2a. Open: Q1, Q3, Q8, Q6, Q5, Q10, Q12 Shorted: Q9, Q4, Q7, CR6, CR8, Q11, Q13 2b. Parallel link open	2a. Check for defective transistor 2b. Check link
3. Poor Regulation	3a. Low gain in amplifier 3b. Defective CR8	3a. Check transistors 3b. Replace
4. Periodic Osc. (hunt)	4a. Open stabilizing capacitor	4a. Check capacitors C5, C7, C8, C9, C13, C14, C11, C12,
5. High ripple on output	5a. Defective filter capacitor 5b. Defective control amplifier 5c. Open: CR1, CR2, CR4	5a. Replace as required 5b. Check transistors and components. Replace as required 5c. Replace as required
6. No Current Limit	6. Q4 open	6. Replace

2. OUTPUT VOLTAGE RANGE ADJUSTMENT

- a. Set the front panel voltage adjustment control (R18) completely counter-clockwise.
- b. Set the reference voltage adjustment potentiometer (R15) to center of its range.
- c. Set the current limit adjustment potentiometer (R6) located on printed circuit board fully clockwise.
- d. Remove the link from between terminals 3 and 4 of TB1 and replace it with a precision 1000 ohm resistance.

With nominal input voltage applied, adjust R15 to obtain an output voltage of $10 \pm .05$ Vdc. This calibrates the voltage programming to 100 ohm/volt

- e. Remove the input power and disconnect the 1000 ohm resistor. Replace the link between terminals 3 and 4 of TB1.
- f. Check the range of the unit (at no load and nominal line) by varying R18.

3. CURRENT LIMIT ADJUSTMENT

- a. Set the output voltage to 10 Vdc, with no load and nominal input voltage.
- b. Set the current limit adjustment potentiometer (R5 located on the printed circuit board) fully counter-clockwise.
- c. Apply a short circuit across the output terminals 1 and 4 of TB1 and adjust R5 as follows:

Model QSA10-1.4 adjust R5 for 1.85 - 1.95 Adc

Model QSA10-2.2 adjust R5 for 2.9 - 3.1 Adc

Model QSA10-3.7 adjust R5 for 4.9 - 5.1 Adc

- d. Remove the short circuit from the output terminals.

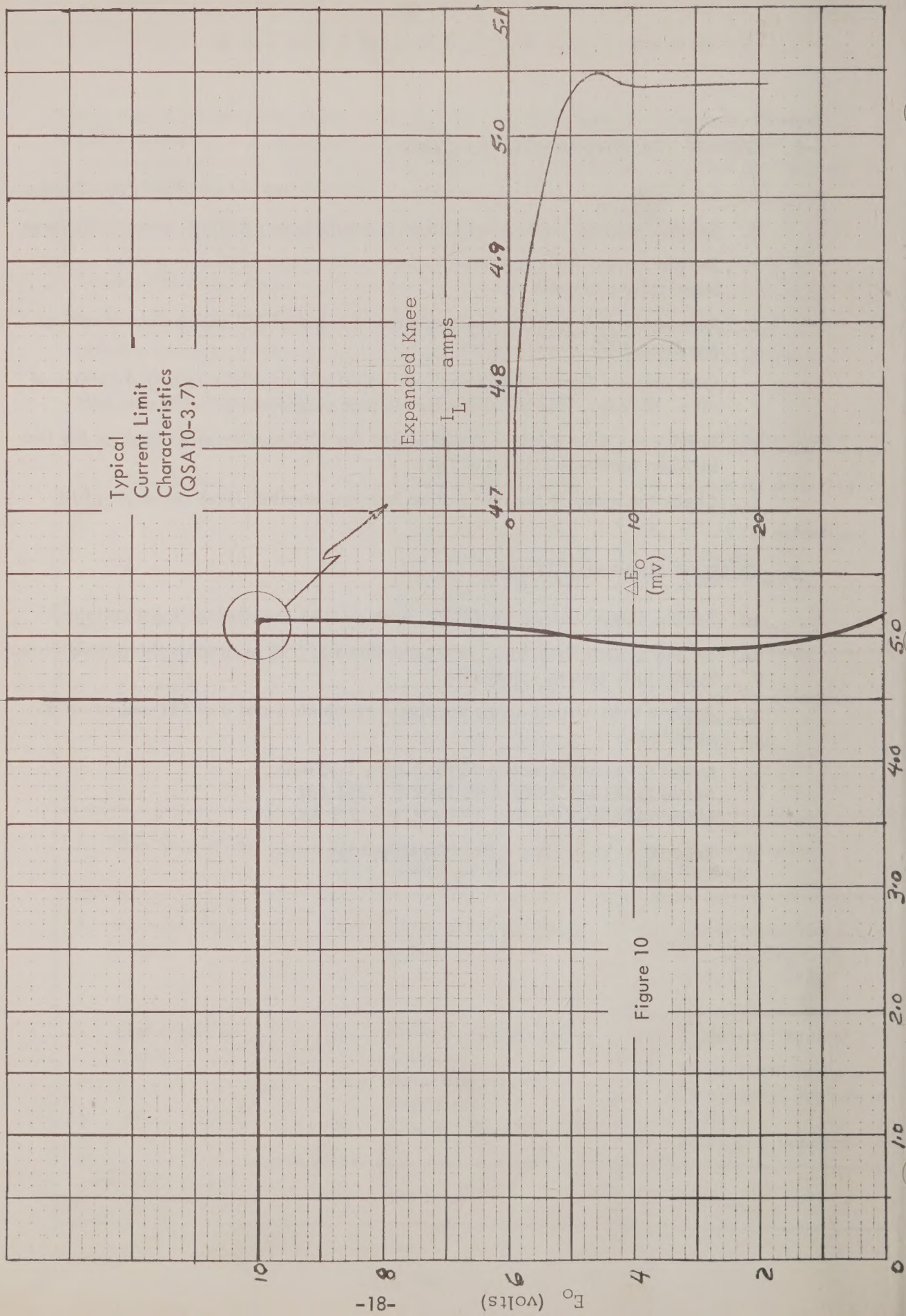
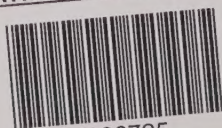


Figure 10

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